Probing the meteoroid environment of planets

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In collaboration with:

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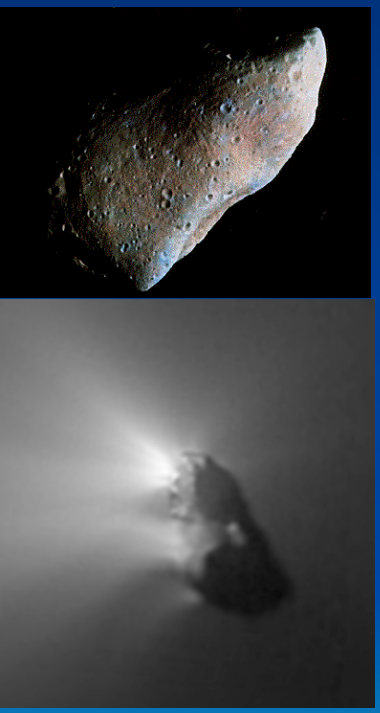
- NASA/JPL: Mars Exploration Rover Team, M. Lemmon, J. Bell, R. Suggs, M. Wolff, E. McCartney, P. Withers
- Univ. Western Ontario, Canada: P. Brown, P. Wiegert, R. Weryck, A. Domokos
- CNRS, France: F. Selsis

Outline

I. Introduction to meteoroids
II. Why? Scientific / Technology interest
III. When? Forecasting of any event
IV. How? Methods - Existing vs needed equipment

I. Introduction to meteoroids

Nasa



ESA

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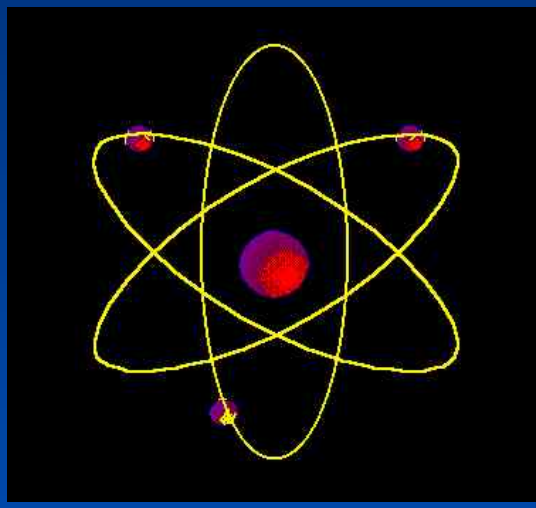


Where do meteroids come from?

73P by HST
Lamy et al.

2 sources:

asteroids

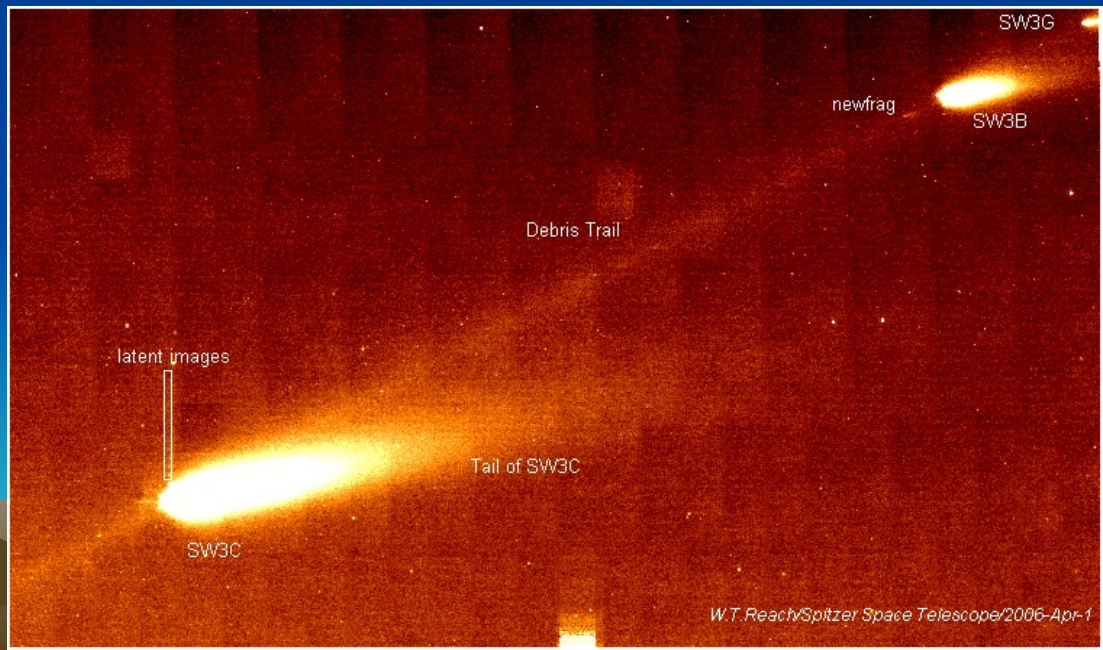
comets

How to observe them?

Vaubaillon, Leonids 2001

- Too big or too small?

73P by the Spitzer Space Telescope (W. Reach)



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Scientific interest of meteoroids
a) Formation of the Solar system

- Meteoroids = brick of ALL the bodies of the Solar System (formation)
- Cometary dust: the less alterated
- There is no mission to a comet able to provide the density of meteoroids (=constraints for the formation of comets)
- unalterated meteoroids are HARD to observe => LOTS of unknown!

Stardust aerogel (JPL/NASA)

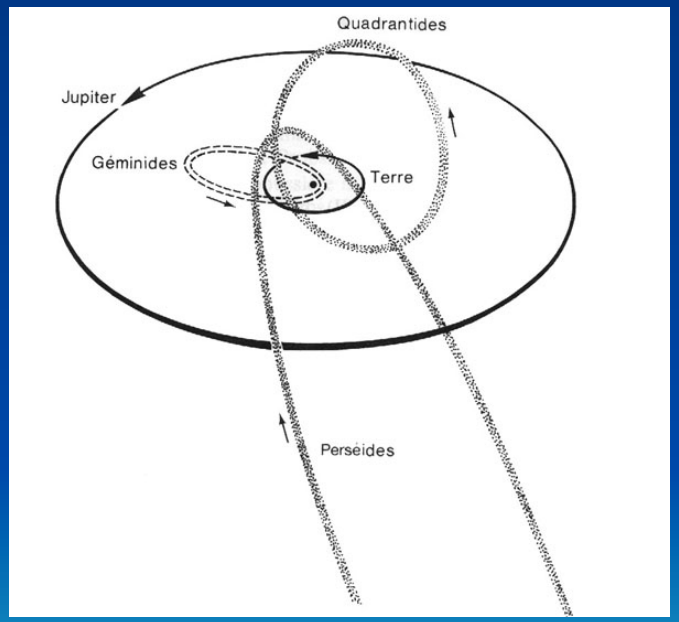
Scientific interest of meteoroids b) exchange of matter

- Constant delivery of mater on planets (Brown et al. 2005) ; most efficient way of transfer of matter and mass between bodies of the Solar System
- Cometary meteoroids: ~90% of total cometary dust mass

- Consequence for exobiology (?)
- Can meteoroids carry cometary organic molecules? (Jenniskens 2004)
- What can survive an atmosphere entry?

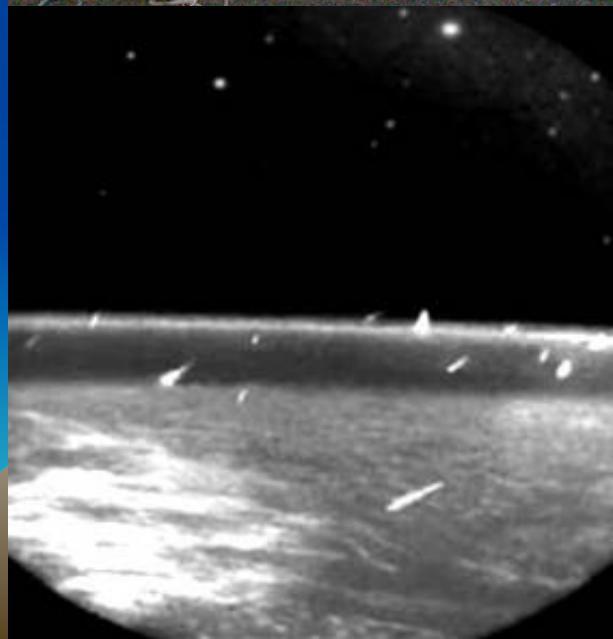
Scientific interest of meteoroids c) Extra-Terrestrial meteors

- Meteoroids are **HARD** to detect
- Earth: nice probe of meteoroid stream at 1 au
- Today: no clue of the environment of other planets
- Other planets: other probes
- Study of ET-atmosphere



Technology interest of meteoroids a) unusual observations

- Small aperture - large FOV
- Fast object!
- Power is critical if not Earth based obs.!

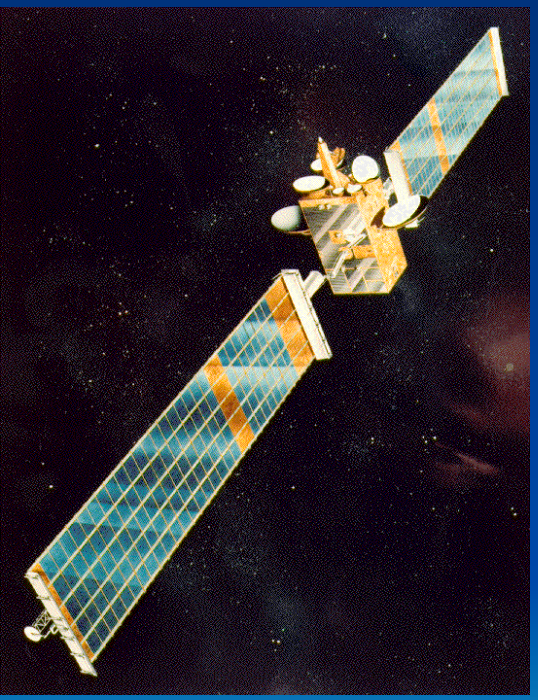


MSX
NASA

Spirit, JPL/NASA

Technology interest of meteoroids
b) Threat for spacecrafts

Olympus, ESA



- Mechanical threat (Mariner IV, HST, Chandra, Shuttle etc.)
- Electrical threat (Olympus)
- Save your spacecraft: turn it off!

Mariner IV (NASA): Sept 1967

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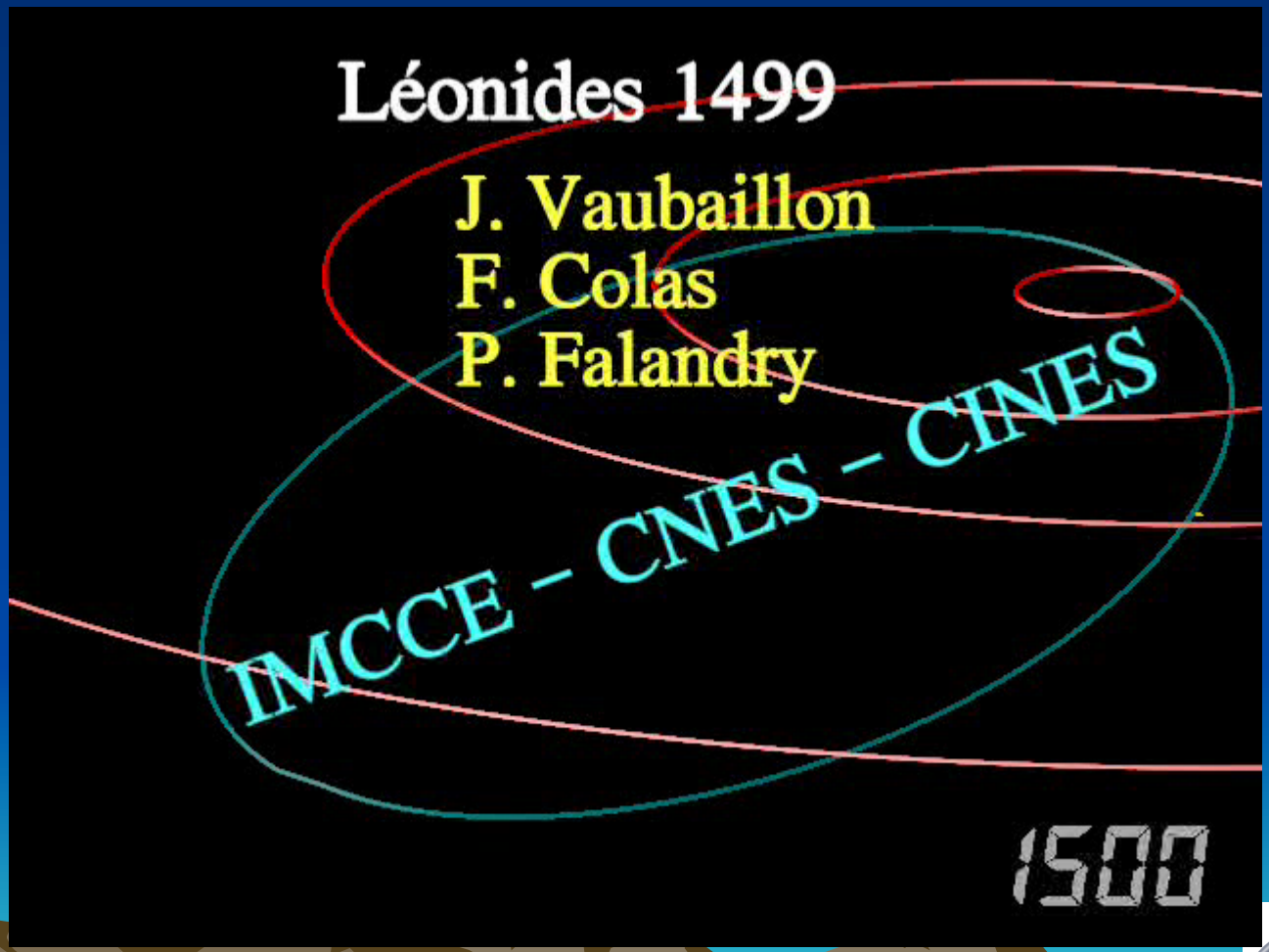
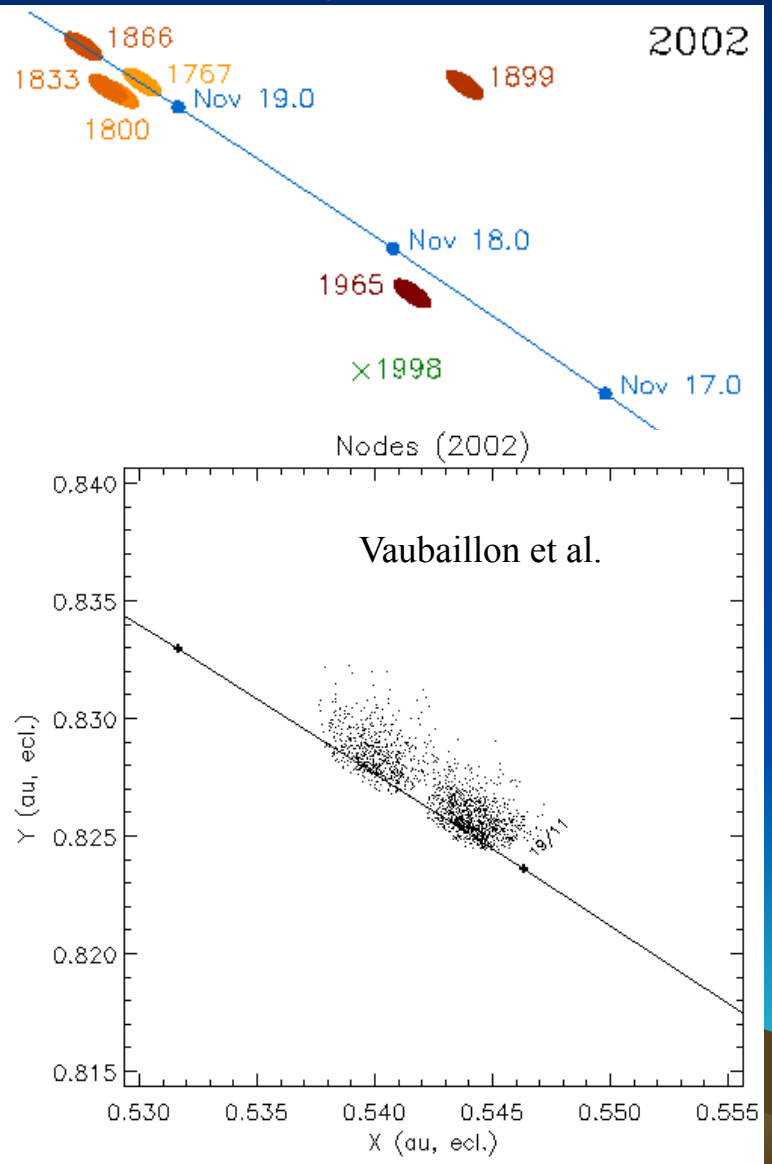
Vaubaillon et al. (2002-2005)

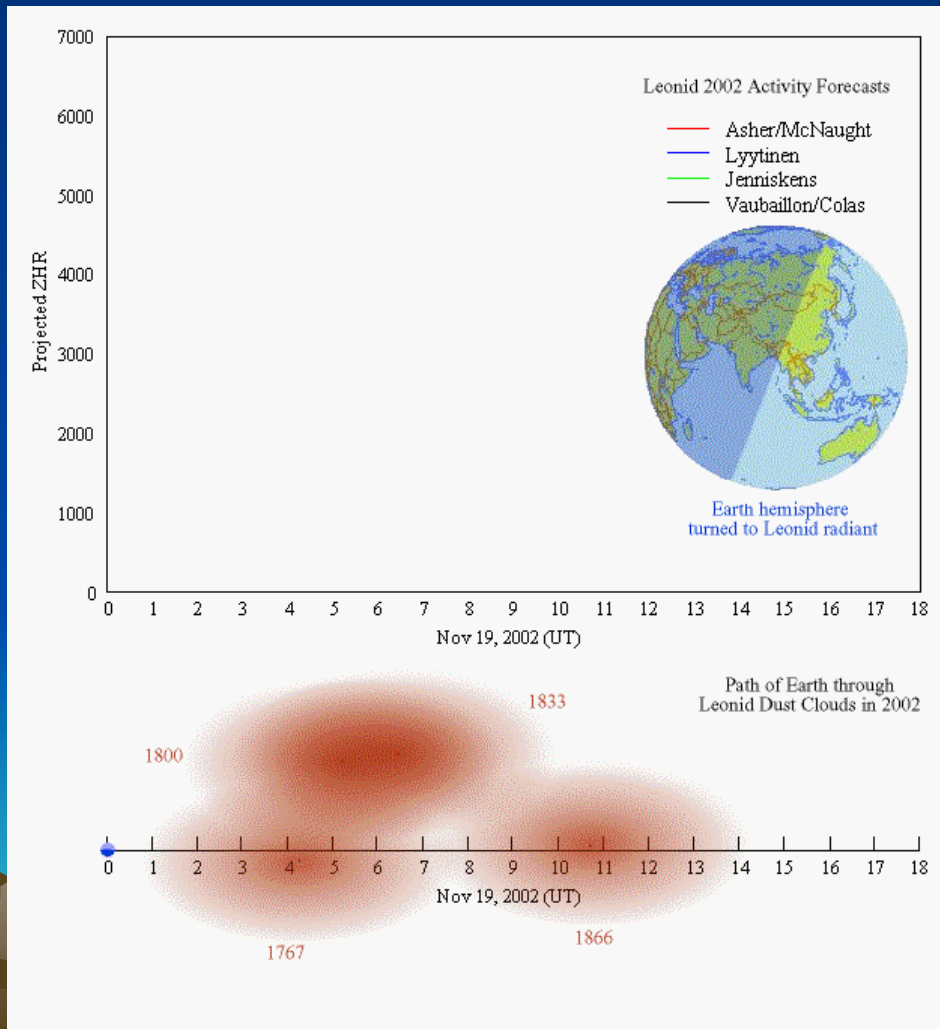


The shower

Asher & McNaught



Cook



Calendar (Mars)

Comet	Date	λ (°)	Dmin (AU)	Vr (km/s)
2001/R1 LONEOS	**10/11/2005**	**30,5**	**0,001**	**11**
1P/Halley	**11/18/2005**	**50,9**	**0,067**	55
146P/Shoemaker-LINEAR (1984W1)	23/11/2005	53,9	0,008	13
1998U5 C/LINEAR	12/17/2005	66,5	0,009	6
114P/Wiseman-Skiff	**1/27/2006**	**87,8**	**0,007**	**11**
1964 VI Tomita-Gerber-Honda	22/05/2006	140,6	0,020	48
P/1991 D1 Hermann	21/07/2006	167,0	0,009	12
9P/Tempel 1	13/01/2007	251,1	0,011	7
45P/Honda-Mrkos-Pajdusakova	13/04/2007	302,9	0,015	23
D/Haneda-Campos (1978R1)	28/04/2007	312,4	0,045	12
C/1974 O1 Cesco	13/06/2007	341,8	0,024	62
85P/Boethin	15/06/2007	343,1	0,055	15

from Selsis et al 2004 + Domokos & Vaubaillon

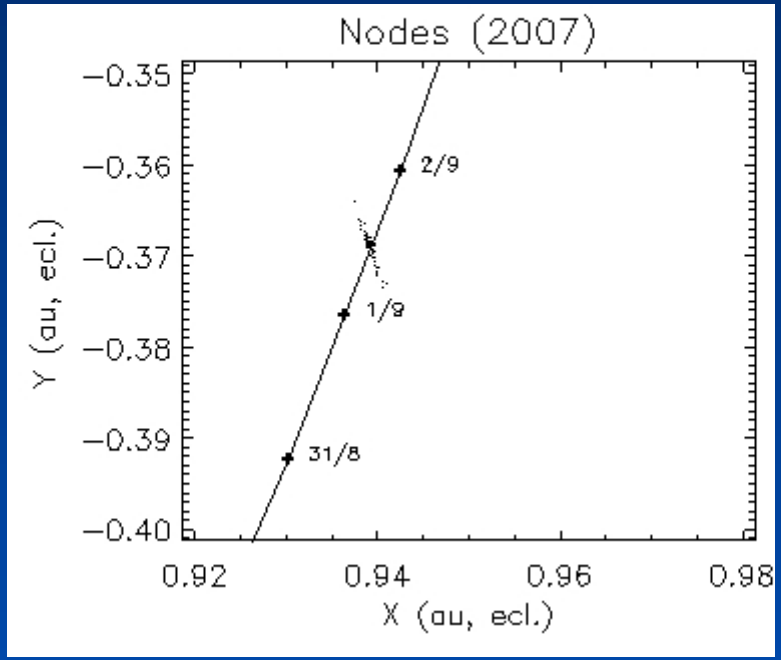
Calendar (Venus)

Comet	Date	Dmin (au)
27P/Crommelin	19 Dec. 2005	0.0255
45P/HMP	6 Jun. 2006	0.0016
27P/Crommelin	1st Aug. 2006	0.0255
45P/HMP	31st Aug. 2006	0.0016
27P/Crommelin	13th Mar. 2007	0.0255
45P/HMP	12th. Apr. 2007	0.0016

From Selsis et al. (2004)

2007 Aurigids

- Parent body: comet C/ 1911 N1 Kiess
- P~2500 yrs
- Last passage: 1911
- pristine layer sample only 100km from us!



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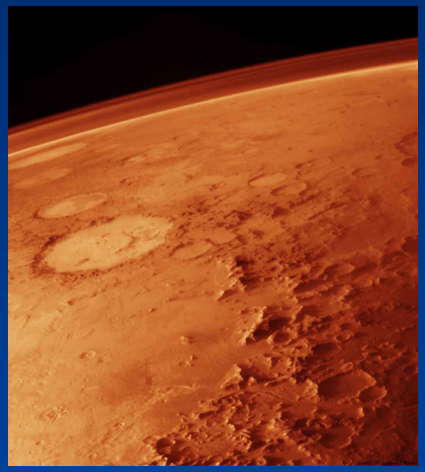
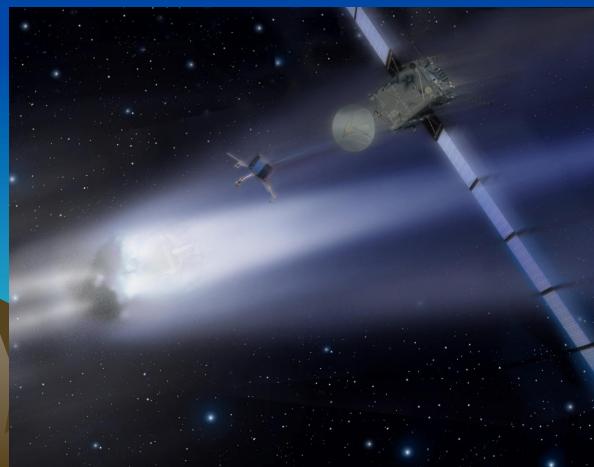
How to create an ET-meteor?

- Planet (+ atmosphere)
- Meteoroid
- Comets help a lot!!!

NASA/JPL



67P & Rosetta (ESA)

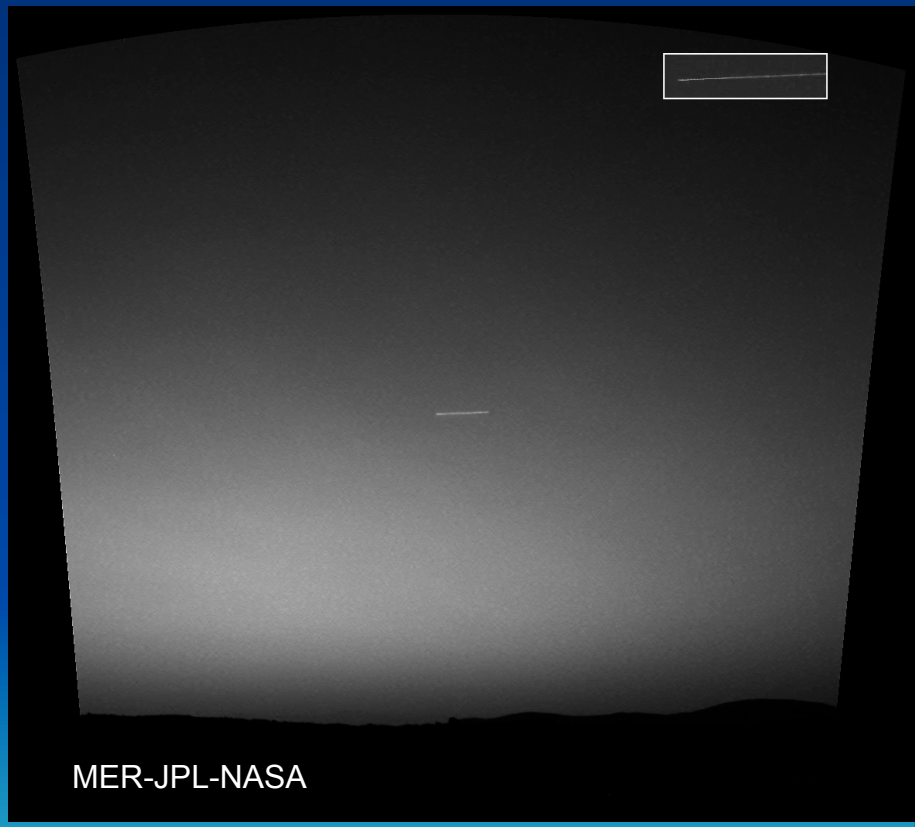


How to observe?
(Ch ed)

-
-
  - exosphere
- VLF/ELF emission

The first detections

- 1st ET-meteor: Jovian atmopshere (Cox Duxbury 1981)
- 1st Martian Meteor: Selsis et al 2004, Nature
- 7th March 2004, at twilight, Navcam 15 sec. exp.

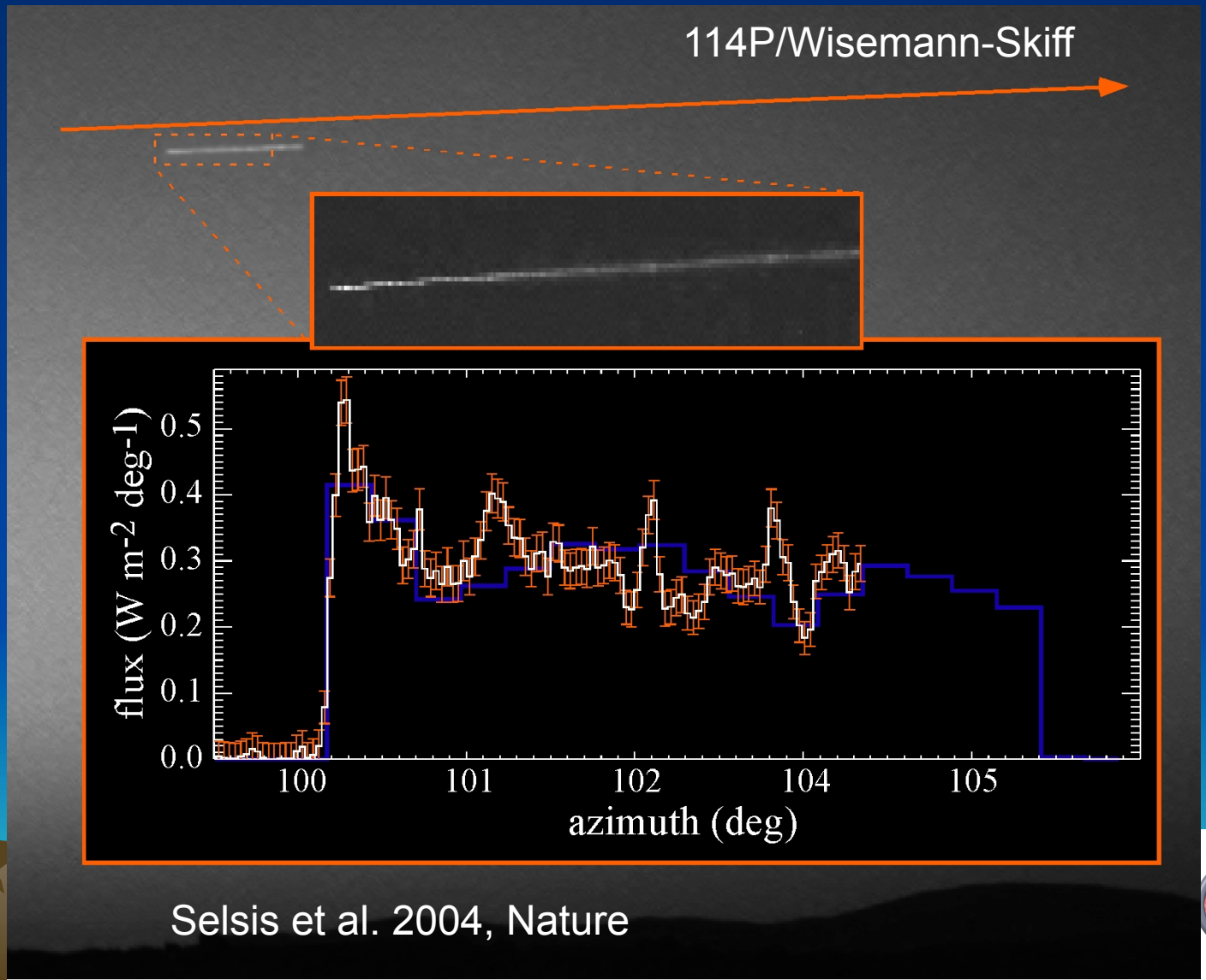


Meteor vs Viking Orbiter 1

- Direction of the orbit matches the streak
- Velocity matches
- Ephemeris lost (70s)

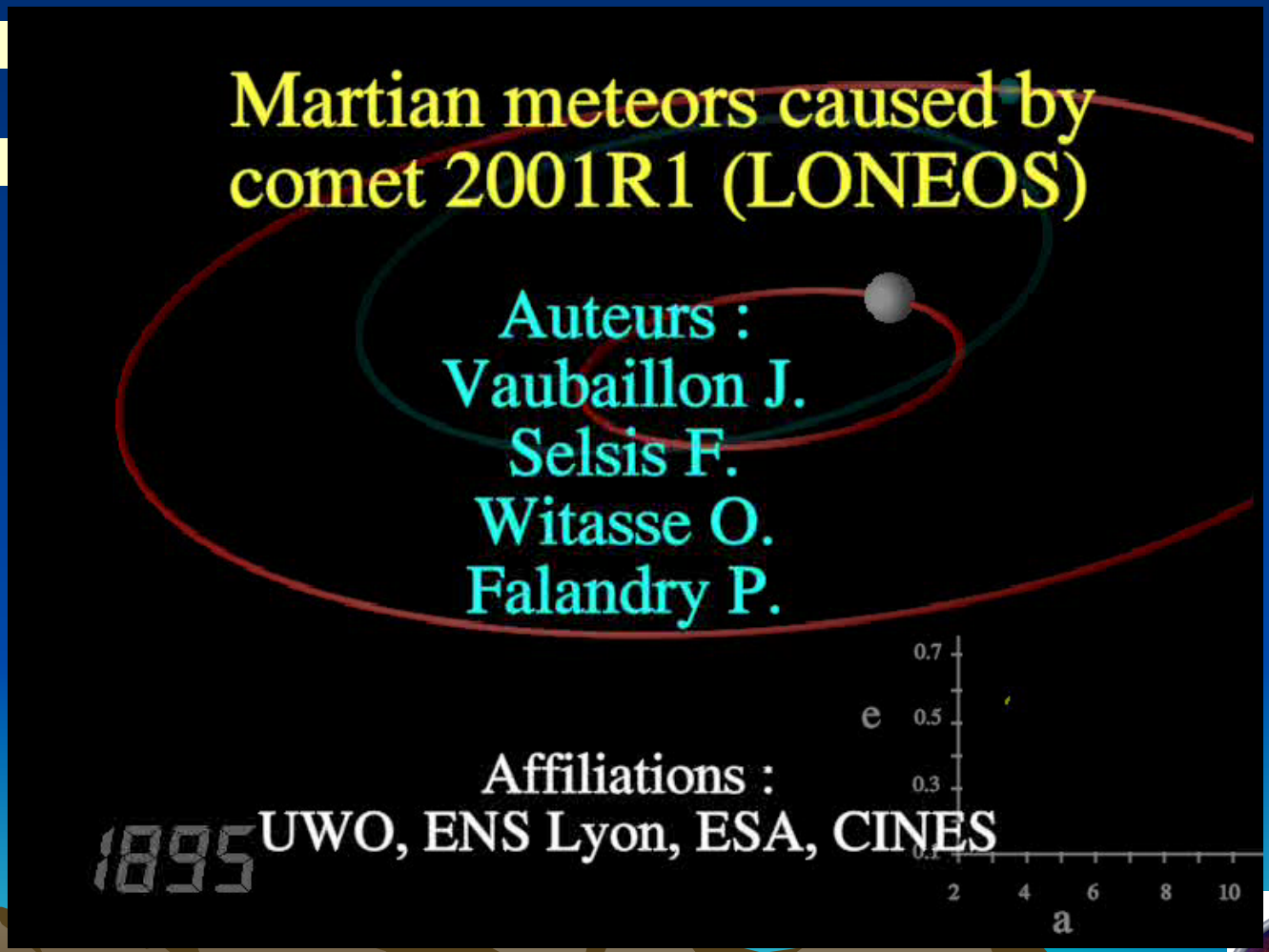
Viking Orbiter 1 (NASA/JPL)

The proof by the light curve



Selsis et al. 2004, Nature

Meteor Shower at Mars 2001R1 LONEOS



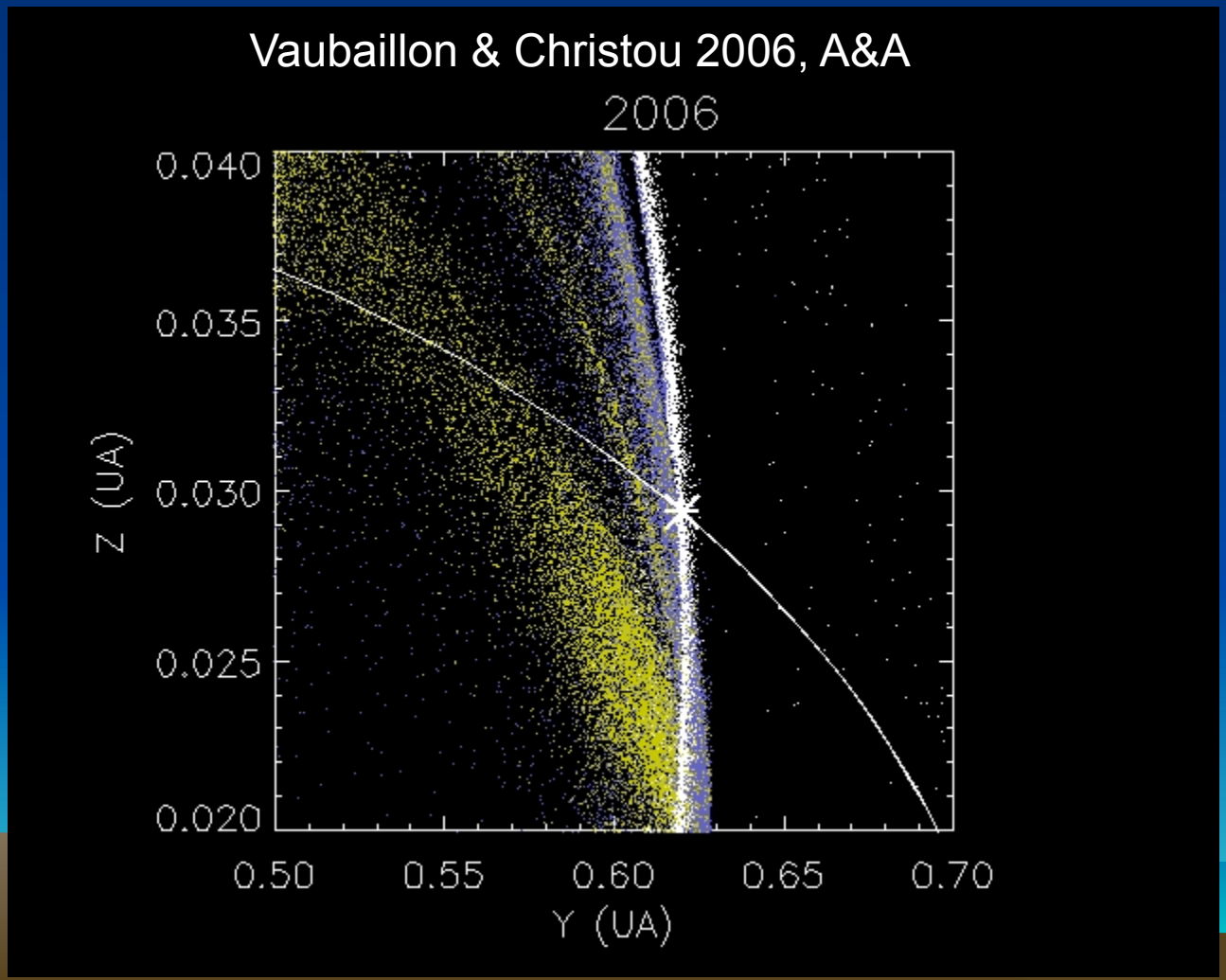
The observations

- Planed 25th-27th Oct.
- Major concern: energy and cosmic rays
- => 9*60 sec exposure
- Minor concern: data downloading (lossless compression)

- Obs. On 25th
- Pb on 26th
- Obs on 28th

MER, NASA/JPL

Venus Express and 45P
6th June 2006



Future detections

- Christou “et Europlanet” (P&SS, submitted) listed at least 4 radio and 6 optical devices able to detect meteoritic activity on Mars and Venus in the coming years
- Dedication
  - not a dedicated mission, but dedicated device for systematic observations
  - ESA onboard meteor detector (demonstrator)

Conclusion (1)

- We still know very few about 90% of the cometary dust mass (meteoroids) distributed in the solar System
- Growing interest of the scientific community
- Scientific and technology challenge
- Meteor shower forecasting are "available"
- Possibilities of observation already exist but not efficient

Conclusion (2)

- Trace of meteoroids may be present in your data (!!!)
- Urgent need for (at least) a dedicated instrument (on-board an orbiter)
- Personal dream: cm-size cometary dust sample return => measure of density

Acknowledgments

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